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Leaf Roll in Relation to Second-Crop Seed Potato Production on Long Island

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A field of second-crop potatoes at Orient, Long Island. Photographed September 2, 1947.

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ABSTRACT

AN ATTEMPT was made to produce disease-free second-crop seed potatoes on Long Island, and data were gathered on the yield potential of northern-grown seed as compared with Long Island second-crop seed.

The leaf roll content of Long Island second-crop seed potatoes is normally high, due to the use of inferior seed stocks, presence of infected volunteer plants in fields, and the difficulty of isolating seed plots.

Because of the isolation problem, it is considered doubtful if disease-free seed could be grown on Long Island, but *reasonably* disease-free seed can be grown if proper precautions are taken.

In general, there was little difference in yield between northern-grown seed and Long Island second-crop seed. Although correlation studies indicated there was some reduction in yield due to high leaf roll content, this was not a significant factor within the limits of the amount of leaf roll present in the seed stocks used.

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LEAF ROLL IN RELATION TO SECOND-CROP SEED POTATO PRODUCTION ON LONG ISLAND

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INTRODUCTION

THE term "second-crop seed" as generally used on Long Island, and as used in this bulletin, refers to a crop of potatoes grown late in the season for seed purposes, usually on land from which a commercial crop of potatoes has been harvested earlier in the season. The second crop is confined almost exclusively to Irish Cobbler, although Green Mountain is grown occasionally. All second-crop plantings are made with northern-grown seed which has been held in cold storage.

Second-crop seed has been grown for a number of years on Long Island, especially in the Orient section. The practice has been more wide-spread during the past few years because of rising costs of seed stocks from northern sources, but it represents only a small fraction of the total amount of seed used in planting the commercial potato crop on the Island.

In the past, Long Island-grown second-crop seed has ordinarily carried a large amount of leaf roll, the leaf roll content running as high as 70 per cent in some instances, while 30 to 40 per cent is not uncommon.

The work reported in this bulletin was undertaken to see if it is possible to produce disease-free second-crop seed on Long Island, to determine the relative yielding ability of second-crop seed as compared with northern-grown seed, and to observe the relation of leaf roll to yield.

GROWING SECOND-CROP SEED

In 1942, when preliminary work was started on this problem, considerable time was spent in making a survey of second-crop potato fields in order to get a better understanding of the conditions under which the crop was grown and to discover, if possible, some expla-

[1] The author is indebted to Dr. W. C. Jacob for assistance and advice in analyzing the data presented in this bulletin.

FIG. 1.— Portion of a potato field showing volunteer plants growing from tubers left in the soil from a crop harvested early in July. Balance of field (extreme left) planted to second-crop potatoes for seed purposes.

nation for the high leaf roll content frequently carried in this seed.

At that time it was found to be a common practice to plant second-crop potatoes on land which had already produced a crop of potatoes the same season. The seed used in planting the first crop might carry anywhere from a mere trace to 10 per cent leaf roll. The aphid population was usually high in these early plantings, with the inevitable result that a considerable spread took place during the growing season. Examination of second-crop fields planted on land from which a crop of potatoes had been harvested earlier in the season invariably revealed some volunteer plants arising from tubers left in the ground at the time the first crop was dug (Fig. 1). In some instances from 8 to 10 volunteer plants have been found in 100 feet of row and, on an average, 50 per cent of these volunteer plants were infected with leaf roll.

Further examination showed that these volunteer plants do not arise from culls or tubers too small to pass over either the digger or the picker, but rather from large tubers lying below the level of the digger point, or from undisturbed portions of deep set tubers which had been cut by the digger point. Usually these volunteer plants are particularly abundant near the end of the row where cutting of tubers by the digger is more likely to occur.

Second-crop plantings are made in late July or early August. At this season of the year warm weather prevails and the plants come up

quickly and make rapid growth. With Irish Cobblers, the type of plant found in second-crop fields is entirely different from that found in spring plantings. The leaves are smaller and the plants are less upright and more spreading. Volunteer plants of this variety have somewhat the same type of growth but are slower in coming above ground. The slower emergence of volunteers is probably largely due to deep soil coverage over the tubers from which they arise, but it may also be due, in part at least, to the condition of dormancy in these tubers. Whatever the cause of delay in emergence, these volunteer plants may be readily overlooked when they appear in the rows.

While some growers make an effort to procure disease-free stock from which to grow their second crop, many of them are not too careful in this respect. Even a small percentage of leaf roll present in seed stock will furnish sufficient inoculum to result in a high percentage of leaf roll-infected tubers in the second crop, provided aphids are present in any quantity during the growing season. The amount of inoculum present in these fields is increased in direct proportion to the number of volunteer plants infected with leaf roll.

Aphids can usually be found on second-crop potato plants shortly after they break through the soil, and are usually plentiful at the time the volunteer plants appear. Some growers make every effort to control aphids by spraying, dusting, or fumigating, but control measures are by no means universal. Successful control of aphids is dependent upon early and frequent application of control measures if transmission of leaf roll is to be avoided.

Time of harvesting will depend somewhat upon the locality in which the second-crop potatoes are grown. In the interior of the Island, the growing period may be considerably shortened by early frost, while in the Orient section frost is not likely to be a factor until late in the season. Generally speaking, the tubers are somewhat immature when harvested.

Leaf roll plants grown from Long Island second-crop seed rarely show the stunting, yellowing, and upright growth often found in plants grown from infected northern seed. The symptoms are of a much milder type. The characteristic curling and crispness of the leaves is present, but the plants are usually only slightly lighter in color than normal plants and make a vigorous growth.

MATERIALS AND METHODS

The work reported in this bulletin was confined to Irish Cobbler.

Early in 1942 seed stock of this variety, known to be low in leaf roll content, was obtained from a commercial source. In March of that year the tubers from this lot were indexed and a single seed piece (also indexed) cut from each tuber. The seed pieces were then planted and disease readings taken during the season. After the seed pieces were removed the indexed tubers were placed in cold storage where they were held until July 20 and were then used for seed in planting a second crop at the Research Farm at Riverhead on that date. This planting was made on land which had not produced a crop of potatoes that season.

When removed from storage, all tubers which showed any evidence of carrying disease of a virus nature, as indicated by the spring index planting, were discarded. This procedure should have insured only healthy seed being used and this was evidently the case, for no plants showing virus symptoms were found in these plantings. However, some transmission from other sources did occur in three of the four years this second-crop seed was grown (Table 1).

The work done in 1942 was of a preliminary nature to insure having clean stock for use in producing second-crop seed for comparison with second-crop seed from other Long Island sources in the 1943 season. Also, it constituted an experiment to see if it were possible to grow disease-free second-crop seed on Long Island, provided precautions were taken to use clean seed and land on which no potatoes had been grown during the current season.

Northern-grown seed for commercial plantings on Long Island comes mainly from three different sources, Maine, New York State, and Prince Edward Island, Canada, Maine being the chief source. With these sources of supply in mind, it was decided to include in this experiment two seed stocks from Maine and one each from New York and Prince Edward Island as representative of northern-grown seed.

Long Island second-crop seed sources included one grown at the Research Farm and one from each of three Long Island growers. Each season an effort was made to get at least one Long Island seed stock likely to carry a high leaf roll content. During the course of the experiment it was not always possible to get seed from the same source each season. However, one source of northern-grown seed and two sources of second-crop seed were available throughout the experiment.

Spring plantings consisted of three-row plots, with a guard row between each series. Eight replications were used throughout. Both planting and harvesting was done with the aid of machinery. Control

of diseases and insects was in accordance with the general recommendations for this area.

Although records were taken as No. 1 and No. 2, the total yield is used in reporting experimental results. All data were subjected to analysis of variance. The percentage of No. 2 tubers, as calculated for individual plots, showed no evidence of correlation between the number of seconds produced and either the seed source or the leaf roll content of any of the seed stocks used.

On Long Island, harvesting of Irish Cobbler usually begins about the first of July. At this time the plants are still green and the tubers immature. Long Island growers have long maintained that, for the early harvest, northern-grown seed will yield heavier than will second-crop seed, but for the late harvest there is little difference in yield between the two seed sources. Since yield records were to be taken, it was decided to procure data on this point. In order to do this, one row in each three-row series was harvested early in July, one row about 2 weeks later, and the third row after the plants had died down.

EXPERIMENTAL RESULTS

PRODUCTION OF DISEASE-FREE SECOND-CROP SEED

During the years 1942–45, second-crop seed potatoes were grown at the Research Farm on land which had not been planted to potatoes earlier in the season. These were grown from selected stock free from leaf roll. Using disease-free seed, and in the absence of volunteer plants, there was no inoculum present in these plantings. That infection did occur, however, is shown by the data given in Table 1. These plantings were by no means isolated but were surrounded by commercial fields, largely planted to late varieties. Undoubtedly, leaf roll was transmitted to the second-crop plants by aphids migrating from these fields. Nicotine dust was used as an aphicide. Although this method of control prevented a heavy build up in aphid population, it was not successful in preventing some infection. This was particularly true in 1945 when commercial fields remained green quite late in the season.

TABLE 1.—PERCENTAGE OF LEAF ROLL IN SECOND-CROP SEED GROWN AT THE RESEARCH FARM, RIVERHEAD, LONG ISLAND.

YEAR	LEAF ROLL, PER CENT
1942	4.6
1943	4.4
1944	0.0
1945	11.9

On the whole, the data presented in Table 1 show that, with proper precautions in using clean seed, planting on land which has not produced a crop of potatoes earlier in the season, and with reasonable control of aphids, it is possible to produce reasonably disease-free second-crop seed on Long Island. With the exception of 1945, the leaf roll content of this seed compares favorably with the average of northern-grown seed on the market during that period. Under Long Island conditions it would be difficult to produce entirely disease-free second-crop seed unless the fields were well isolated, or possibly in a season such as 1944 when the plants in commercial fields died down very early.

COMPARATIVE YIELDS OF NORTHERN-GROWN AND SECOND-CROP SEED POTATOES

In 1943 there was a noticeable difference in the time of emergence of plants from northern-grown seed as compared with Long Island second-crop seed. The northern-grown seed came up more uniformly than did the second-crop seed and the stand was complete 10 days earlier. Following emergence, however, plants from the second-crop seed grew rapidly, and 3 weeks after emergence there was no apparent difference in vigor and growth of plants from the two seed sources. This difference in time of emergence was much more marked in 1943 than in any other season the experiment was in progress. In fact, the difference in time of emergence of plants from these two seed sources was so slight in 1944, 1945, and 1946 as to be negligible.

The yield of second-crop seed in 1943 (Table 2) was lower than that of northern-grown seed in all harvests, but the figures are not significant for the late harvest nor are they significant in all cases in the two early harvests.

The season of 1944 was one of the driest on record and potato yields on Long Island were well below normal, except where irrigation was available. No irrigation was available for the experimental plots and the plants began to die down earlier than usual. For that reason, the second harvest was made a week later than the first as it was feared the plants would be entirely dead if a 2-week interval were allowed. Individual plot yields were erratic, but the average yield of eight replications, as given in Table 3, show very little difference in yield between various seed sources and in very few instances are the figures significant.

Potato yields were heavy in 1945. In the early harvest, as shown by the data in Table 4, the trend was towards lower yields from second-

TABLE 2.—YIELD IN BUSHELS PER ACRE FROM NORTHERN-GROWN AND LONG ISLAND SECOND-CROP SEED POTATOES, PLANTED MARCH 31, 1943.

SEED SOURCE	DATE HARVESTED			LEAF ROLL, PER CENT
	July 1	July 14	Aug. 9	
Northern Seed				
Maine (a)	111	267	243	3.2
Maine (b)	92	257	246	7.2
Prince Edward Island	103	257	261	2.1
New York State	94	265	238	1.0
Long Island Second-crop Seed				
Research Farm	65	238	230	4.6
Long Island (1)	75	241	236	21.8
Long Island (2)	57	205	234	33.8
Long Island (3)	69	215	231	33.3
L.D. (19–1)	15.30	26.10	21.43	

crop seed, but there is little significant difference in these figures. The later harvests showed a trend in the other direction.

The 1946 season was again a favorable one for potatoes and yields were heavy. There is little difference in yield in any of the harvests between the various seed sources (Table 5).

From the data given in the tables it is difficult to tell just how much influence a high leaf roll content in any one seed source had upon yield. The data of each year were analyzed to determine the correlation between leaf roll and yield. This analysis showed that, in general, high leaf roll content was associated with lower yields.

TABLE 3.—YIELD IN BUSHELS PER ACRE FROM NORTHERN-GROWN AND LONG ISLAND SECOND-CROP SEED POTATOES, PLANTED APRIL 7, 1944.

SEED SOURCE	DATE HARVESTED			LEAF ROLL, PER CENT
	July 6	July 13	Aug. 7	
Northern Seed				
Maine (a)	128	130	117	2.7
Maine (c)	111	112	115	12.9
Prince Edward Island	116	123	103	4.1
New York State	121	126	121	3.0
Long Island Second-crop Seed				
Research Farm	136	143	138	4.4
Long Island (1)	106	126	123	20.2
Long Island (4)	93	94	105	42.5
Long Island (5)	106	115	108	34.9
L.D. (19–1)	41.49	50.40	36.75	

TABLE 4.—YIELD IN BUSHELS PER ACRE FROM NORTHERN-GROWN AND LONG ISLAND SECOND-CROP SEED POTATOES, PLANTED APRIL 4, 1945.

SEED SOURCE	DATE HARVESTED			LEAF ROLL, PER CENT
	July 2	July 17	July 31	
Northern Seed				
Maine (a)	276	327	320	2.9
Maine (d)	263	336	331	4.4
Prince Edward Island	267	302	318	0.5
New York State	281	312	338	0.2
Long Island Second-crop Seed				
Research Farm	254	334	328	0.0
Long Island (1)	266	348	371	1.2
Long Island (6)	254	308	346	0.2
Long Island (3)	252	338	334	0.2
L.D. (19–1)	20.08	47.97	44.44	

TABLE 5.—YIELD IN BUSHELS PER ACRE FROM NORTHERN-GROWN AND LONG ISLAND SECOND-CROP SEED POTATOES, PLANTED MARCH 26, 1946.

SEED SOURCE	DATE HARVESTED			LEAF ROLL, PER CENT
	July 3	July 16	Aug. 12	
Northern Seed				
Maine (a)	226	309	345	10.4
Maine (e)	209	309	333	11.2
Prince Edward Island	222	319	335	5.1
New York State	209	328	355	1.1
Long Island Second-crop Seed				
Research Farm	211	311	327	11.9
Long Island (1)	205	294	323	21.1
Long Island (7)	217	338	335	2.4
Long Island (3)	224	321	357	16.9
L.D. (19–1)	36.14	37.55	45.70	

DISCUSSION AND SUMMARY

In those areas where seed production is a major effort on the part of potato growers, it has generally been recognized that certain precautions must be taken to insure disease-free stock. These precautions include the use of clean seed, rotation in order to eliminate any possibility of volunteer potato plants, early roguing to remove diseased plants, and isolation of seed plots from commercial fields.

The problem of growing disease-free second-crop seed on Long Island is not a simple one, but in the past too little attention has been paid to the importance of these necessary precautions. Too frequently, the stock used for second-crop plantings has carried too high a leaf roll content to be satisfactory for seed production purposes.

Second-crop plantings for seed purposes are ordinarily made on land which has produced a crop of potatoes the same season, and almost every year volunteer plants appear late in the season from tubers left in the soil. A large percentage of these volunteers are infected with leaf roll and serve as a source of inoculum for infection of second-crop plants.

In the past, little or no roguing has been done in second-crop plantings. Roguing would probably be of some value in preventing spread of leaf roll. Early removal of all infected plants, including volunteers, would remove the source of inoculum, but it is of doubtful value if aphids have become well established before the roguing is done.

Depending upon seasonal conditions, the plants in commercial fields adjacent to or near second-crop fields may or may not be dead during the early growth period of second-crop plants. Aphids can usually be found in second-crop plantings shortly after the plants appear above ground. As the plants in commercial fields die down, there may be considerable aphid migration to the more succulent second-crop plants. Many of these aphids have been feeding on leaf roll-infected plants and already carry the virus. Prompt application of an aphicide is necessary to prevent infection.

Long Island growers can do much toward reducing the leaf roll content of second-crop seed by using disease-free stock for planting, by planting on clean land, and by the intelligent use of an aphicide.

Guarding against infection from outside sources is, in some sections at least, a difficult problem. Long Island is an intensive potato-growing area and it is rarely possible to isolate fields intended for seed production. In some seasons complete isolation might occur if the plants in commercial fields died down early enough, but with more extensive use of irrigation and the control of leaf hoppers achieved by the use of DDT, the chances of isolating seed plots is very remote.

Because of the isolation problem alone, it is doubtful, except in rare seasons, if it is possible to produce disease-free second-crop seed potatoes on Long Island, but it is possible, with proper precautions, to reduce the amount of leaf roll infection to a point where it compares favorably with many lots of northern-grown seed.

Potato yields are influenced by many factors among which may be mentioned soil variation and the inherent yielding ability of the seed stock. In the experiment reported here there was considerable variation in soil type in the experimental field, and it is to be expected that there would be some variation in the inherent yielding ability of the various seed stocks used.

It has been generally recognized that leaf roll plants do not yield as heavily as healthy plants. That healthy plants adjacent to diseased plants may yield heavier and thus compensate to some extent for the lower yield of diseased plants has long been suspected. Blodgett[2] has proposed a method for determining losses due to diseased plants based on the proximity of diseased to heathy plants. Tuthill and Decker[3] applied this method to two varieties in fields where leaf roll was present. They found that the yield of healthy plants adjacent to diseased plants was higher than the average for healthy plants not in close proximity to diseased plants. On the basis of this work, they present a table showing the percentage loss to be expected with a given percentage of leaf roll plants in a field. With Irish Cobbler the loss due to 30 per cent leaf roll was 11.5 per cent, while with 40 per cent leaf roll the loss was only 15.8 per cent. Later work by Kirkpatrick and Blodgett[4] confirmed these results, although the average loss for the three varieties used in this experiment was slightly lower. LeClerg, *et al.*,[5] state that the chances are slight for a marked reduction in yield with 4 per cent leaf roll; and furthermore, the number of instances in which significant reduction in yield occurred with 8 per cent leaf roll were relatively few. In some of their experiments the point of significant reduction in yield was found to be between 32 and 100 per cent diseased plants.

It is evident from the work quoted above, that the percentage of leaf roll plants present in any given field must be relatively high before there is any serious reduction in yield. The highest leaf roll count in any of the seed sources used in the work reported here was 40 per cent. Although correlation studies between leaf roll and yield indicate that

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[2] Blodgett, F. M. A method for the determination of losses due to diseased or missing plants. *Amer. Pot. Jour.*, **18**: *132–135. 1941.*

[3] Tuthill, C. S., and Decker, Phares. Losses in yield caused by leaf roll of potatoes. *Amer. Pot. Jour.*, **18**: *136–139. 1941.*

[4] Kirkpatrick, H. C., and Blodgett, F. M. Yield losses caused by leaf roll of potatoes. *Amer. Pot. Jour.*, **20**: *33–56. 1943.*

[5] LeClerg, E. L., *et al.* Effect of different amounts of spindle tuber and leaf roll on yields of Irish potatoes. *Amer. Pot. Jour.*, **21**: *60–71. 1944.*

there was some reduction in yield due to leaf roll, it was not a significant factor under the conditions of the experiment.

The data presented show that second-crop seed will give yields comparable to northern-grown seed, provided the leaf roll content is not abnormally high.